

AD 718576

7 May 1968

Materiel Test Procedure 6-3-183
U. S. Army Artillery Board

U. S. ARMY TEST AND EVALUATION COMMAND
COMMODITY SERVICE TEST PROCEDURE

3466

CLOUD HEIGHT SET

1. OBJECTIVE

The purpose of this MTP is to describe the methods, techniques, and test requirements necessary for the determination of the degree to which a cloud height set can perform the mission prescribed for it in the applicable qualitative material requirements (QMR) and technical characteristics (TC) and its suitability for use by the Army.

2. BACKGROUND

Cloud height can have extensive effects on military operations especially those being conducted in mountainous regions and/or rugged terrain. Among the adverse effects of cloud height or ceiling military operations are:

- a. Restriction of target observation from ground positions and the observation of activities or near critical terrain features.
- b. Restriction of aerial surveillance by airplane pilots and observers.
- c. Limitations imposed on take-offs and landings of military aircraft forces with the necessary aerial support, such as bombing attacks on specific targets.
- e. Lessening of the time for observers to acknowledge the approach of hostile aircraft to key positions and, hence, a reduction of the chances for an effective response.

Low cloud cover does afford opportunities to reflect searchlight beams into, otherwise, inaccessible areas which could be an advantage.

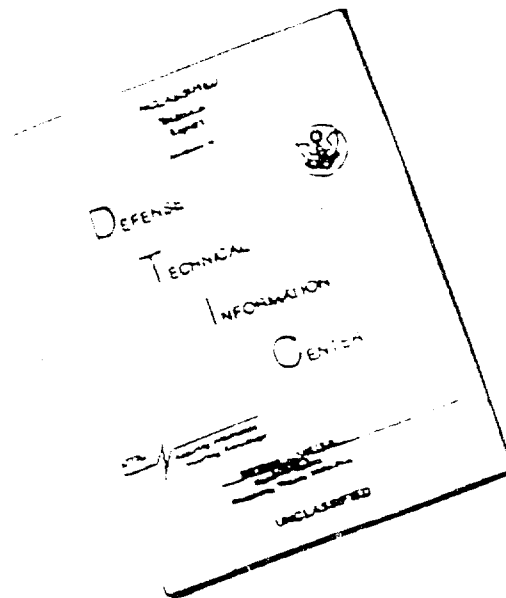
The height of clouds, therefore, must be determined as quickly and accurately as possible by relatively simple means. Continuing development of equipment for performing this operation dictates that operational evaluations, of such equipment, are needed.

3. REQUIRED EQUIPMENT

- a. Suitable Test Sites and Facilities, for conducting the applicable subtests.
- b. Maintenance Support Facilities, as required.
- c. Communications Equipment and Facilities, as required
- d. Equipment and Facilities as required by the referenced MTP's
- e. Vehicles for Transporting of Test Equipment and Personnel, as required
- f. Balloon Inflating, Tethering and Launching Equipment, as required
- g. Timing Unit
- h. Clinometer

2004 0204 084

DISCLAIMER NOTICE



THIS DOCUMENT IS BEST
QUALITY AVAILABLE. THE COPY
FURNISHED TO DTIC CONTAINED
A SIGNIFICANT NUMBER OF
PAGES WHICH DO NOT
REPRODUCE LEGIBLY.

- i. "Standard" Item, for comparison, as required
- j. Acoustic Aids
- k. Optical Instruments
- l. Electronic Ranging Instruments
- m. Camouflage Materials, as required
- n. Aerial Cameras with Film
- o. Aerial Photo Interpretation Facilities
- p. Repair Parts, as required
- q. Road Test Courses, as follows:
 - 1) Paved roads
 - 2) Unpaved roads
 - 3) Cross-country terrain
- r. Surveyed Positions

4. REFERENCES

- A. USAMC Regulation 385-12 Safety
- B. USATECOM Regulation 385-6 Safety Release
- C. USATECOM Regulation 385-7 Safety Confirmation
- D. USATECOM Regulation 750-15 Maintenance of Supplies and Equipment
- E. AR 705-15 Operation of Materiel under Extreme Conditions of Environment
- F. DA FM 6-15 Artillery Meteorology
- G. MTP 6-3-182 Balloons (Meteorological)
- H. MTP 6-3-500 Physical Characteristics
- I. MTP 6-3-501 Technical Inspection
- J. MTP 6-3-502 Personnel Training Requirements
- K. MTP 6-3-505 Emplacement, Preparation for Action, and March Order
- L. MTP 6-3-506 Durability
- M. MTP 6-3-509 Effects of Weather
- N. MTP 6-3-512, Compatibility with Related Equipment
- O. MTP 6-3-514, Qualitative Frequency Accuracy and Stability
- P. MTP 6-3-517 Electrical Power Requirements
- Q. MTP 6-3-523 Safety
- R. MTP 6-3-524 Maintenance Evaluation
- S. MTP 6-3-525 Human Factors
- T. MTP 7-3-512 Air Drop Capability (Suitability of Equipment For)
- U. MTP 7-3-515 Air Transport, Internal (Suitability of Equipment For)
- V. MTP 7-3-516 Air Transport, External (Suitability of Equipment For)
- W. MTP 10-3-502 Durability
- X. MTP 10-3-503 Surface Transportability
- Y. MTP 10-3-510 Logistics-Over-The-Shore (LOTS)

5. SCOPE

5.1 SUMMARY

This MTP describes the methodology, techniques and the tests required

48040504005

7 May 1968

for the determination of the man-equipment compatibility and the capability and suitability of the test item as a cloud height measuring instrument. The major areas and their included subtests are:

a. Pre-Test Operations consisting of:

- 1) Technical Inspection - A check to verify that the test item is complete and in satisfactory condition prior to the start of testing.
- 2) Physical Characteristics - A verification of the physical characteristics of the test item.
- 3) Electrical Characteristics - A study to ascertain the test item's electrical characteristics and a determination of its power requirements.

b. Operational Characteristics consisting of:

- 1) Emplacement, Preparation for Action and March Order Suitability - A study to determine the ability of service personnel to set up the test item for operation under various conditions and to restore it to its transport configuration.
- 2) Measurement Accuracy - A study to determine degree of accuracy of measurement that the test item is capable of as compared to a "standard" item.
- 3) Frequency Accuracy and Stability - A study to determine the capability of the test item to maintain accurate operating frequencies under field conditions.
- 4) Balloon Systems Capability - A study to determine the suitability of a meteorological balloon for use as a cloud height measuring device.

c. Transportability Tests consisting of:

- 1) Surface Transportability - A study to determine the suitability of the test item for surface transport.
- 2) Air Transportability - A study to determine the suitability of the test item for transport by aircraft both internally and externally.
- 3) Air Drop Capability - An evaluation of the suitability of the test item for air drop operations.
- 4) Logistics-Over-the-Shore - A study to determine the capability of the test item to withstand logistics-over-the-shore operations and its suitability for such operations.

d. Vulnerability to Detection - A study to determine the degrees of security from aural and visual detection that the test item, has in its various modes. Ground and aerial observations are included.

e. Compatibility with Related Equipment - A study to determine the suitability of the test item for operations with its related equipment, in various configurations.

f. Full-Test Evaluations consisting of:

7 May 1968

- 1) Durability - An evaluation of the capability of the test item to withstand being transported over various types of terrain for a specified number of miles.
- 2) Maintainability and Reliability - An evaluation to determine the suitability of the test item to be maintained, the adequacy of its maintenance package, and its overall ability to operate over long periods of time without adjustment or replacement of components.
- 3) Effects of Weather - An evaluation of the effects of various weather conditions on the operability of the test item.
- 4) Human Factors - An evaluation of the suitability of the test item for operation, servicing, transport and storage by service personnel without causing undue fatigue and mental errors.
- 5) Safety - An evaluation of the safeness of the test item in its various configurations, under a variety of conditions, and the resultant safety hazards to service personnel.

g. Post-Test Inspection - A repetition of the technical inspection to determine any adverse effects of testing on the test item.

In addition, APPENDIX A discusses the measurements of cloud-base heights and provides additional background information.

5.2 LIMITATIONS

None

6. PROCEDURES

6.1 PREPARATION FOR TEST

6.1.1 Scheduling

6.1.1.1 Personnel

a. Ensure the availability of service personnel who have been trained according to the criteria of MTP 6-3-502 and are knowledgeable about the following aspects of the test item:

- 1) Installation
- 2) Operation
- 3) Maintenance

b. Record the following for all service test personnel:

- 1) Rank
- 2) MOS
- 3) Training time
- 4) Experience

7 May 1968

NOTE: Test personnel shall receive the minimum essential individual instruction in the operation and organizational, direct support and general support maintenance of the that item. The achievement of a skill level to operate the test item under simulated combat conditions shall be a requirement, assuming that the test item can achieve results as set forth in the applicable QMR. Observations of operations and maintenance activities shall be made by technically qualified personnel.

c. Ensure that experienced personnel are available for the duration of testing.

6.1.1.2. Facilities and Equipment

a. Select and schedule the use of testing sites and facilities as required by the applicable subtests.

b. Upon notice of the arrival or estimated time of arrival of the test item, arrange for or secure the following:

- 1) Engineering safety release or a safety statement from the engineering agency as prescribed by references 4B and 4C.
- 2) Vehicles for transporting the test items, as applicable.
- 3) Maintenance support facilities, organization and personnel.
- 4) Assistance of the U. S. Army Airborne, Electronics and Special Warfare Board (USAAESWBD), as required, during the conduct of aerial delivery and air drop operations.
- 5) Assistance of the U. S. Army General Equipment Test Activity (USAGETA), as required, during the conduct of logistics-over-the-shore operations.
- 6) Verify that surveyed positions, as required, at the testing sites, are available.

6.1.2. Safety

a. Verify that the test item safety statement is valid and up-to-date.

b. Verify that all service test personnel have been adequately trained in the safety requirements pertaining to the test item and the testing.

6.1.3. Pre-Test Operations

The following paragraphs (6.1.3.1 through 6.1.3.3) shall apply to test items consisting of electronic components.

6.1.3.1 Technical Inspection

Conduct a technical inspection of the test item as described by the applicable sections of MTP 6-3-501.

6.1.3.2 Physical Characteristics

7 May 1968

Determine the physical characteristics of the test item as described by the applicable sections of MTP 6-3-500.

6.1.3.3 Electrical Characteristics

Determine the electrical characteristics and the power requirements of the test item as described by the applicable sections of MTP 6-3-517.

6.2 TEST CONDUCT

a. Subtests shall be conducted concurrently with, or in conjunction with, other subtests, whenever possible, so that the time taken to collect the required data can be minimized.

b. Subtests shall be conducted under the conditions of weather prevailing during the period of testing.

c. All subtests shall apply to test items consisting of electronic components unless otherwise specified.

6.2.1 Operational Characteristics

At the completion of each subtest for the evaluation of operational characteristics, the test item shall be subjected to a technical inspection as described by the applicable sections of MTP 6-3-501. (except as specified)

6.2.1.1 Daylight Conditions

Perform paragraphs 6.2.1.1.1 through paragraph 6.2.1.1.4 under daylight conditions:

NOTE: For test items which depend upon a visual sighting or the reception or location of a light beam, then, visibility conditions must be good.

6.2.1.1.1 Emplacement, Preparation for Action and March Order Suitability - Determine the suitability of the test item for being emplaced, prepared for action, and march ordered according to the criteria of MTP 6-3-505.

NOTE: This subtest shall be performed in conjunction with other operational subtests, as applicable.

6.2.1.1.2 Measurement Accuracy - Perform the following using a test item and a "standard" item emplaced at the same site:

NOTE: A "standard" item shall be a cloud height set presently in use.

- a. Determine and record the height of the cloud-base.
- b. Repeat step a until a minimum of three observations have been made by each of two operator teams.
- c. Record the following for each observation:

- 1) Item identity

7 May 1968

6.2.1.1.3 Frequency, Accuracy and Stability - Determine the qualitative frequency accuracy and stability of the test as described by the applicable sections of MTP 6-3-514.

6.2.1.1.4 Balloon Systems Capability - Perform the following for balloon system cloud height sets only:

a. Prepare the balloon system for launch operations as described by the applicable sections of MTP 6-3-182.

b. Determine and record the following for a released balloon:

- 1) Ascensional rate
- 2) Vertical angle, with respect to the observer, at which the balloon enters the cloud-base.
- 3) Time of flight until cloud entry.

c. Repeat steps a and b until a minimum of three observations have been made.

d. Complete the necessary post-test steps as described by MTP 6-3-182.

6.2.1.2 Darkness (Blackout) Conditions

Repeat paragraphs 6.2.1.1.1 through paragraphs 6.2.1.1.3 under darkness conditions, as applicable.

6.2.2 Transportability Tests

6.2.2.1 Surface Transportability

a. Determine the surface transportability of the test item as described by the applicable sections of MTP 10-3-503.

b. At the completion of the testing, subject the test item to a technical inspection as described by the applicable sections of MTP 6-3-501.

6.2.2.2 Air Transportability

NOTE: The conduct of air transportability testing shall be coordinated with the U. S. Army Airborne, Electronics and Special Warfare Board (USAAESWBD).

6.2.2.1 Internal Transport - Perform the following:

a. Determine the suitability of the test item for internal air transport as described by the applicable sections of MTP 7-3-515.

b. At the completion of the testing, subject the test item to a technical inspection as described by the applicable sections of MTP 6-3-501.

6.2.2.2.2 External Transport - Perform the following:

7 May 1968

- a. Determine the suitability of the test item for external air transport as described by the applicable sections of MTP 7-3-516.
- b. At the completion of the testing, subject the test item to a technical inspection as described by the applicable sections of MTP 6-3-501.

6.2.2.3 Air Drop Capability

- a. Determine the suitability of the test item for air drop operations as described by the applicable sections of MTP 7-3-512.

NOTE: The conduct of airborne operations shall be the responsibility of the U. S. Army Airborne, Electronics and Special Warfare Board (USAAESWB).

- b. At the completion of the testing, subject the test item to a technical inspection as described by the applicable sections of MTP 6-3-501.

6.2.2.4 Logistics-Over-the-Shore

- a. Determine the capability of the test item for logistics-over-the-shore as described by the applicable sections of MTP 10-3-510.

NOTE: Logistics-over-the-shore requirements shall be coordinated with the U. S. Army General Equipment Test Activity (USAGETA).

- b. At the completion of the testing, subject the test item to a technical inspection as described by the applicable sections of MTP 6-3-501.

6.2.3 Vulnerability to Detection

Observations of the test item shall be made during the following test item emplacement conditions:

- a. Operational
- b. Standby

6.2.3.1 Daylight Conditions

- a. Determine and record the maximum distance at which the test item and its associated power equipment are audible to:

- 1) Unaided ear
- 2) Acoustic aids

- b. Determine and record the maximum distances at which the test item is discernible without camouflage and with camouflage from ground positions using:

- 1) Unaided vision
- 2) Optical instruments
- 3) Electronic instruments, when applicable

7 May 1968

c. Determine and record the maximum attitudes at which the test item is discernible without camouflage and with camouflage from aerial observations using:

- 1) Unaided vision
- 2) Optical instruments
- 3) Aerial photography

NOTE: The conduct of airborne operations shall be the responsibility of the U. S. Army Airborne, Electronics, and Special Warfare Board (USAAESWBD).

6.2.3.2 Darkness (Blackout) Conditions

Repeat paragraph 6.2.3.1 under conditions of darkness (blackout).

6.2.4 Compatibility with Related Equipment

Determine the compatibility of the test item with related components and devices as described by the applicable sections of MTP 6-3-512.

6.2.5 Full Test Evaluations

During the conduct of this MTP, the following test item characteristics shall be determined and/or evaluated.

6.2.5.1 Durability

a. Determine the durability of the test item as described by the applicable sections of MTP 6-3-506.

NOTE: The test item shall be transported over paved roads, unpaved roads, and cross-country terrain for a minimum of 300 miles, in all transportable configurations.

b. Evaluate the ability of the test item transit case(s) to protect the test item from shock and vibration.

6.2.5.2 Maintainability and Reliability

NOTE: The overall evaluation of the maintainability and reliability of the test item shall be made according to the criteria of reference 4D.

a. Complete the authorized maintenance tasks in accordance with the test item maintenance instructions and technical literature.

b. Determine the maintainability of the test item as described by the applicable sections of MTP 6-3-524.

c. Record the following, as applicable:

- 1) Time and number of personnel required to perform scheduled

- and non-scheduled maintenance tasks on the test item.
- 2) Frequency of repairs
- 3) Test item down-time (cumulative)
- 4) Nomenclature of repair parts used

d. Evaluate the adequacy and accuracy of the test item maintenance package.

6.2.5.3 Effects of Weather

- a. Determine the effects of weather on the test item operability as described by the applicable sections of MTP 6-3-509.
- b. Evaluate the ability of the test item transit case(s) to protect the test item from moisture, dust and other debris.

6.2.5.4 Human Factors

- a. Determine the suitability of the test item design with respect to the man-equipment relationship as described by the applicable sections of MTP 6-3-525 and MTP 6-3-182, as required.
- b. Determine and record the suitability and the compatibility of the test item with the service personnel who will operate and service it, with respect to their skills, aptitudes and physical limitations.

NOTE: Each test item detail requiring human attention and/or manipulation shall be observed and evaluated.

6.2.5.5 Safety

- a. Determine the test item safety hazards resulting from storage, transport, operation, and maintenance as described by the applicable sections of MTP 6-3-523.
- b. Prepare a safety confirmation in accordance with USATECOM Regulation 385-7.

6.2.6 Post-Test Inspection

Upon completion of testing the test item shall be subjected to a technical inspection as described by the applicable sections of MTP 6-3-501 and any deleterious effects on the test item, due to the testing program, shall be recorded.

6.3 TEST DATA

6.3.1 Preparation for Test

6.3.1.1 Personnel

Record the following for all service personnel:

- a. Rank

7 May 1968

- b. MOS
- c. Training time in months
- d. Experience in years

6.3.1.2 Pre-Test Operations

6.3.1.2.1 Technical Inspection -

Record data as collected under the applicable sections of MTP 6-3-501.

6.3.1.2.2 Physical Characteristics -

Record data as collected under the applicable sections of MTP 6-3-500.

6.3.1.2.3 Electrical Characteristics -

Record data as collected under the applicable sections of MTP 6-3-517.

6.3.2 TEST CONDUCT

6.3.2.1 Operational Characteristics

Record the following for each subtest conducted:

- a. Visibility condition (daylight, darkness)
- b. Test item nomenclature
- c. "Standard" item nomenclature, as applicable

6.3.2.1.1 Emplacement, Preparation for Action, and March Order Suitability -

- a. Record data as collected under the applicable sections of MTP 6-3-505.
- b. Record technical inspection data, collected as described in the applicable sections of MTP 6-3-501.

6.3.2.1.2 Measurement Accuracy -

a. Record the following for each observation:

- 1) Height of the cloud-base, in feet or meters, as applicable
- 2) Item identity (test item, "standard" item)
- 3) Operator team identity (by designation)
- 4) Observation number (1, 2, 3)

b. Record technical inspection data, collected as described in the applicable sections of MTP 6-3-501.

6.3.2.1.3 Frequency, Accuracy and Stability -

- a. Record data as collected under the applicable sections of MTP 6-3-514.

b. Record technical inspection data, collected as described in the applicable sections of MTP 6-3-501.

6.3.2.1.4 Balloon Systems Capability -

Record the following for balloon systems only:

- a. Ascensional rate in feet per minute.
- b. Vertical angle, with respect to the observer, at which the balloon enters the cloud base layer, in degrees.
- c. Time of flight until cloud entry in seconds.

6.3.2.2 Transportability Tests

6.3.2.2.1 Surface Transportability -

- a. Record data as collected under the applicable sections of MTP 10-3-503.
- b. Record technical inspection data, collected as described in the applicable sections of MTP 6-3-501.

6.3.2.2.2 Air Transportability -

a. For internal transport:

- 1) Record data as collected under the applicable sections of MTP 7-3-515.
- 2) Record technical inspection data, collected as described in the applicable sections of MTP 6-3-501.

b. For external transport:

- 1) Record data as collected under the applicable sections of MTP 7-3-516.
- 2) Record technical inspection data, collected as described in the applicable sections of MTP 6-3-501.

6.3.2.2.3 Air Drop Capability -

- a. Record data as collected under the applicable sections of MTP 7-3-512.
- b. Record technical inspection data, collected as described in the applicable section of MTP 6-3-501.

6.3.2.2.4 Logistics-Over-the-Shore -

- a. Record data as collected under the applicable sections of MTP 10-3-510.
- b. Record technical inspection data, collected as described in the applicable sections of MTP 6-3-501.

6.3.2.3 Vulnerability to Detection

- a. Record the following for each aural observation:
- 1) Visibility condition (daylight, darkness)
 - 2) Maximum distances, in meters, at which the test item and associated equipment can be detected by:
 - a) Unaided ear
 - b) Acoustic aids
 - 3) Test item operational condition (operational, standby)
- b. Record the following for each visual observation from ground positions:
- 1) Visibility condition (daylight, darkness)
 - 2) Test item emplacement condition (camouflaged, uncamouflaged)
 - 3) Maximum distances, in meters, at which the test item is discernible by:
 - a) Unaided vision
 - b) Optical instruments
 - c) Electronic instruments, when applicable
- c. Record the following for each visual observation from aircraft:
- 1) Visibility condition (daylight, darkness)
 - 2) Test item emplacement condition (camouflaged, uncamouflaged)
 - 3) Maximum altitudes, in feet or meters, at which the test item can be detected by:
 - a) Unaided vision
 - b) Optical instruments
 - c) Aerial photography

6.3.2.4. Compatibility with Related Equipment

- a. Record data as collected under the applicable sections of MTP 6-3-512.
- b. Record technical inspection data, collected as described in the applicable sections of MTP 6-3-501.

6.3.2.5. Full-Test Evaluations

6.3.2.5.1 Durability -

Record data as collected under the applicable sections of MTP 6-3-506.

6.3.2.5.2 Maintainability and Reliability -

Record the following:

- a. Data as collected under the applicable sections of MTP 6-3-524.
- b. Type of maintenance performed (scheduled, non-scheduled)
- c. Time required to perform each maintenance task in hours
- d. Number of personnel required to perform each maintenance task
- e. Frequency of repairs over the period of testing (record dates)
- f. Test item down-time (cumulative) in hours
- g. Nomenclature of repair parts used

6.3.2.5.3 Effects of Weather -

Record data as collected under the applicable sections of MTP 6-3-509.

6.3.2.5.4 Human Factors -

Record the following:

a. Data as collected under the applicable sections of MTP 6-3-525 and MTP 6-3-182, as required.

b. Observations of service personnel during testing, and the suitability of the test item with respect to their:

- 1) Skills
- 2) Aptitudes
- 3) Physical limitations

6.3.2.5.5 Safety -

Record data as collected under the applicable sections of MTP 6-3-523.

6.3.2.6 Post-Test Inspection

a. Record data as collected under the applicable sections of MTP

6-3-501.
b. Record any deleterious effects of the test program on the test item.

6.4 DATA REDUCTION AND PRESENTATION

Data obtained from all subtests covered by applicable MTP's shall be summarized, compared with "standard" data, and evaluated according to procedures described in those applicable MTP's. Appropriate charts, graphs, and tabulated summaries shall be used to present the data in a clear manner. Special consideration shall be given to any condition or circumstance contributing to any test result.

Calculations shall be performed as specified by the individual MTP's, wherever applicable, and all photographs, motion pictures, and illustrative material shall be suitably identified.

The evaluation of the test item measurement accuracy shall be based

MTP 6-3-183
7 May 1968

on the summarized data and on the comparison with data produced by the "standard" item.

The qualitative and quantitative data collected shall also be evaluated in terms of the requirements specified in the QMR's and TC's, which are applicable, to determine the degree of fulfillment of the test item performance specifications.

For the evaluation of the vulnerability of the test item, to detection, average distances and altitudes shall be computed, tabulated, and compared for the various observation methods under the various conditions.

A safety confirmation based on the data of paragraph 6.3.2.3.5, shall be presented in accordance with USATECOM Regulation 385-7.

APPENDIX A

MEASUREMENTS OF CLOUD HEIGHTS

Modern techniques for measuring cloud heights employ such devices as ceiling balloons, ceiling light projectors, ceilometers, and very short-wave (1cm.) radar. In addition, cloud heights have been estimated by triangulation methods; by optical range finders, by intersections of clouds with hills or mountains, or by application of the dew point formula. In the latter method, when the air is thoroughly mixed as far as the base of the cloud, the height of the base of a cumulus cloud may be calculated from the surface temperature (T) and the dew point temperature (T_d), both in degrees F., by the following equation:

$$\text{Cloud Height (in feet)} = 225 (T - T_d)$$

An accurate and convenient method, available for ceiling measurements during the hours of darkness, is the use of the ceiling light. In this device, a small searchlight projects a narrow beam of light, of less than 3° spread, vertically upward to the base of the cloud. An observer, stationed at 500 to 1000 feet from the projection, sights on the spot of light on the lower surface of the cloud and measures the vertical angle (θ) to the spot. If the baseline distance (L) between the projector and the observer is measured then

$$\text{Cloud Height} = L \tan \theta$$

The accuracy of this method is adequate for airways purposes, but it is limited chiefly by the degree of uniformity of the underside of the cloud layer and by the accuracy with which the vertical angle can be measured. With a 500 ft. baseline, an uncertainty of 2° in the angle will result in an error of approximately 300 ft. for a cloud height of 2000 ft. Under ideal conditions, cloud heights have been determined by this method up to 15,000 ft. to an accuracy of about 2,500 ft.

In daylight the spot from the ceiling light projector is, of course, invisible, since the sky may be 1,000,000 times as bright as the spot. This difficulty has been resolved by using a light modulated to a known frequency, and observing the spot by means of a special telescope equipped with a photo-electric cell at the focal point of a large lens. Electrical filters, used in conjunction with the photo-electric cell, reject all signals except those of the modulating frequency. These signals are then amplified sufficiently to operate an electric meter. This device, known as a ceilometer can measure cloud heights up to 10,000 ft. in daylight and about 20,000 ft. in darkness. It is widely employed at civilian air terminals as well as by the military services.

Radar equipment has been developed that not only measures the height of cloud-bases, but also permits detailed study of the vertical structure of clouds. The development in the early 1950's of the radar cloud-base and cloud-top indicator represented a significant advance in meteorological instrumentation. It has been shown both theoretically and experimentally that microwaves of approximately 1 cm. wave length are scattered by cloud water droplets

of radii between 10 and 30 μ . Short microwave pulses of a few microseconds duration are radiated upward toward the cloud from a parabolic mirror six feet in diameter. These pulses are then scattered back toward the antenna from the top and bottom of each successive layer of clouds. From the time interval between the transmission of the pulse and the returned cloud echo; the height of the echoing surface above the radar can be computed.

Radar sets operating at these short wave-lengths have detected clouds to heights in excess of 45,000 ft. It has also been possible to locate clouds through several thousand feet of light rain. However, the minimum cloud altitude that can be measured is about 800 ft., this limitation being due to the recovery time of the radar receiver.